The PPPL Highlights for the week ending May 6, 2016 are as follows:

FEATURED HIGHLIGHT (M. ONO):

J. Berkery and S. Sabbagh (NSTX-U Team collaborators–Columbia University), along with colleagues Yueqiang Liu (CCFE) and H. Reimerdes (EPFL), were awarded the 2016 Landau-Spitzer Award, presented jointly every two years by the American and European Physical Societies (APS and EPS). The Award is given to an individual or group of researchers for outstanding theoretical, experimental, or technical contribution(s) in plasma physics, and for advancing the collaboration and unity between the European Union and the United States. The research for which the award was given comprises nearly a decade of published effort on kinetic resistive wall mode theory validation and understanding, which included experiments from NSTX and DIII-D. The award also merits an invited talk on the research to be presented at the EPS Conference on Plasma Physics, July 4-8 in Leuven, Belgium.

U.S. ITER FABRICATION (C. NEUMEYER):

Steady State Electric Network (SSEN):

Uninterruptible Power Supply (UPS) system and DC Distribution: Minor comments were received from PNNL on the RFP package for the UPS. After another iteration with PNNL, the package will be submitted for DOE PSO review. The DC Distribution procurement value falls below the review threshold so it will not been sent to PNNL/DOE, but has been held back in case comments from the PNNL review seem appropriate for incorporation.

Power Transformers: Minor comments were received from ITER IO on the Lot 3 Release for Shipping (RFS) documentation package so another iteration with the supplier is necessary. Target shipping date remains May 17. Factory Acceptance Testing (FAT) of the Lot 1 and Lot 2 transformers was completed and correction of punch-list items is underway. Target shipping date is June 13.

Diagnostics:

Low Field Side Reflectometer (LFSR): The PPPL LFSR team has found a solution to allow for more neutron shielding around the LFSR corrugated wave guide integrated into Russia DA Equatorial Port 11 DSM-1. PPPL is working closely with the Russia DA port integration team to

find ways to reduce neutron streaming to other DSMs in EP11 and to the back closure plate of EP11.

The LFSR subcontractor, General Atomics (GA), has issued a draft report laying out the hardware and the control strategy to protect the reflectometry instruments against unabsorbed ECH radiation and millimeter waves coming out from the ITER experimental plasmas.

Electron Cyclotron Emission (ECE): An ECE technical status meeting at University of Texas (UT) at Austin is scheduled for July 6. This meeting will determine the status of the hot source design, and readiness to the peer review in the fall. Currently, tests are underway on the prototype design including radiative heat exchange between the off the shelf heater, and silicone carbide emitter. Emissivity of the inconel heater is reduced to 0.4 after bakeout, during which the beneficial effect of manufacturer recommended oxidation is removed. This low emissivity impedes radiative heat transmission to the emitter, and forces the heater to work at an elevated temperature. Various methods of improving heat transfer are currently investigated at UT such as, modifying emitting surface with sandblasting, silicon carbide coating, or direct contact heating of the emitter. Numerical analysis is also performed to support the experiments. At PPPL, design of a push-rod actuator concept is underway with initial variant of the design already implemented into CATIA. Some adjustments of the design are needed, as well as detailing of mechanical feed-through. Detailing of the test protocols for an alternative piezo electric actuator assessment is currently underway.

Toroidal Interferometer and Polarimeter (TIP): The TIP in-vessel turning mirrors must maintain precision alignment and not become distorted under the thermal and mechanical loads they will experience in harsh environment of the ITER port plug. They must also be maintainable by robotic tools. R. Wood has completed scoping studies on several designs for these mirrors. A document is being assembled that compares these designs and down-selects from among them for the Preliminary Design Review.

Diagnostic I&C Integration Engineering: Work continues on finalizing preliminary cable design packages consisting of Piping and Instrumentation Diagrams (P&IDs), Single-Line Diagrams (SLDs), and Cable Collection Lists (CCLs). The IO needs these packages to support cable tray design and definition of other building interfaces. The focus to date has been on Diagnostics on floor level L1. Significant comments were received from GA for TIP and LFSR and those comments are being addressed. Documentation for ECE is undergoing review in iDocs. Documents for all other USDA diagnostics on L1 (DRGA, CIXS, MSE, LFSR, EP03, and EP09) have gone through at least one IDM review cycle. Comments from these reviews are being addressed.

NSTX-U (M. ONO):

A FY2016 NSTX-U plasma operations update: The department has completed 7.91 run weeks and 823 plasma shots. The total operation target is 18 run weeks.

J. P. Allain of the University of Illinois at Urbana-Champaign visited PPPL last Friday. His group developed the Materials Analysis and Particle Probe (MAPP). The MAPP has been installed on NSTX-U, and operated in collaboration with researchers from PPPL and B. Koel's

group from Princeton University's Department of Chemical and Biological Engineering. It has been used to introduce samples of plasma-facing components (PFCs) into NSTX-U, and analyze their surfaces without breaking vacuum. The results for samples using X-ray photoelectron spectroscopy after boronization with deuterated trimethyl borane was discussed. The sample surfaces did evolve between boronizations, with different boron compounds forming with time. However, they appeared to recover the same characteristics after each boronization. It was concluded that surface analysis of samples should be performed with greater spectral resolution, and plans were made to remove them from MAPP after boronization for measurements in laboratory facilities with higher sensitivity.

May 2 was largely spent troubleshooting problems with the OH supply. Towards the end of the day, tests were done on the PF-1c upper and lower coils, where the coil currents were measured by both the legacy Halmar transducers and the new LKAT transducers. These tests showed that the current ripple measured by all transducers was the same for the PF-1cU coil. However, the legacy Halmar transducers significantly underestimate the current ripple for the PF-1cL coil. One plasma shot was taken at the end of the day.

May 3 was dedicated to XMP-152 (Improved dr-sep control and rtEFIT checkout, M. Boyer), using ohmic helium plasmas. This tested both an improved version of dr-sep control recommended by GA, and the new multi-threaded rtEFIT code. Both of these were successful, including running the new rtEFIT version which fits both coil currents and vessel currents in realtime while basically maintaining the cycle time of the previous version. However, towards the end of the day, a bug was found in the shape control code, which disabled the physics operator request for the upper X-point position. The source of the bug was only identified on the evening of May 3, and was corrected for operation on the next day. A number of vacuum field shots were then taken under XMP-106 (Magnetics calibrations, C. Myers) with the goal of assessing if the interaction between the OH and TF coils produces any meaningful error fields in NSTX-U. The OHxTF interaction was a substantial problem in NSTX and was therefore designed out in NSTX-U by placing the OH leads at the bottom of the coil, and using a coaxial lead system. The vacuum field shots were designed to demonstrate that the OHxTF error fields are, in fact, absent. Preliminary analysis indicates that the OHxTF error fields in NSTX-U are less than 1 G, which is substantially smaller than in NSTX.

May 4 started with a couple of shots of XMP-152. These demonstrated that the bug in the X-point control code was fixed. The rest of the day was spent on XMP-150 (He Density Scan for Zeff Measurements, C. Skinner and R. Bell), which continued the use of ohmic helium plasmas. A density scan was completed, including plasmas with Greenwald fractions up to approximately one. Preliminary analysis of the data shows that the photometric calibrations of the visible bremsstrahlung diagnostics are largely valid, with the inferred Zeff trending towards approximately 2 at higher density as expected. These ohmic shots had high values of the internal inductance, creating a difficult operating space constrained by coil force limits and vertical stability; ultimately the best shots for this XMP was achieved in inner-wall limited plasmas.

On May 5, shots were dedicated to XMP-151 (L-mode development, W. Guttenfelder) with a focus of establishing higher power, and diverted L-mode plasmas. The day began attempting to repeat the last 650 kA L-mode fiducial run prior to the maintenance period, but the discharge exhibited many L/H and H/L transitions. Increased HFS fueling was used over many shots to raise the plasma density in a 800 kA diverted target, approaching Greenwald fraction of 0.5,

which prevented transition into H-mode. Various combinations of NBI #1 sources were used to inject up to 4.3 MW of power at the higher target density. Shots with injected powers between 3.5-4.3 MW appeared to be limited either by transition to H-mode or strong MHD activity, establishing an effective limit around ~3 MW.

Most of May 6 was dedicated to XMP-142 (H-mode scenario development). The goal was to reproduce previous long-pulse scenarios, but using ISOFLUX control of the divertor coils. It was found that the L-H transition was more reproducible when near a double null shape with 4.5MW NBI heating, however this shape can be difficult to maintain as the shot evolves. Good progress was made in reproducing a high-triangularity H-mode scenario with 6MW NBI, however, the discharges tended to divert too early, leading to a "low-li" evolution that can disrupt due to low q-shear. Future work will ensure these discharges divert later. The end of the day was dedicated to continuing XMP-151 (L-mode development), with the goal of increasing plasma current. A number of shots were required to establish the higher density/gas fuelling conditions necessary for the 800 kA, 2.5 MW L-mode. Then, 900 kA and 1.0 MA discharges were run successfully to the OH current limit, with q95~3.7 in the 1.0 MA scenario.

The reinstallation of the 16-channel UCLA reflectometer system at Bay-J is nearing completion. BNC data and power cable terminations (45 cables in total) are almost complete. One of two digitizers has developed an ethernet communication problem, which is being addressed. It is anticipated that first data will be obtained next week during plasma ops.

ITER & TOKAMAKS (R. HAWRYLUK):

DIII-D (R. Nazikian):

The OMFIT suite of modules for preparing, executing and visualizing TRANSP analysis has been upgraded to include TRANSP "ACFILE" output that includes the neutral beam fast-ion distraction function, beam ion birth profiles and beam neutral density for use in fast-ion studies. This new capability improves the efficiency of displaying fast-ion related quantities relevant to experiment and facilitates the development of an integrated workflow within OMFIT for fast ion physics studies.

N. Logan, C. Paz-Soldan, J. Park, and R. Nazikian's paper, "Identification of multi-modal plasma responses to applied magnetic perturbations using the plasma reluctance," was published in Nuclear Fusion this week. The paper identifies the multi-modal plasma response observed in DIII-D n=2 RMP experiments using a new reluctance eigenbasis. The reluctance basis is related to previous metrics, including the perturbed energy and resonant current drive, enabling diagnosis of the plasma modes and their multi-faceted impact on plasma performance using external magnetic fields.

L. Cui has had her APS invited paper published on line in Physics of Plasmas. The paper is titled "Spontaneous profile self-organization in a simple realization of drift wave turbulence."

B. Tobias met with students and staff at UC Davis who are completing the development of an advanced heterodyning receiver circuit that has been designed with the support of PPPL for use in microwave imaging diagnostics such as ECEI and MIR. The new circuit integrates low noise

GaAs, MMIC amplifiers, and mixers on an advanced liquid crystal polymer (LCP) substrate including a highly directional antenna. Dramatically improved rejection of out-of-band electromagnetic interference and a 10x improvement in noise temperature promise to expand the capabilities of ECEI on DIII-D for imaging ELMs and other edge fluctuations. Additionally, this integration improves reliability and serviceability of ECEI/MIR systems with cost savings and significantly reduced complexity over implementation with discrete components. B. Tobias will present the status of this development and measured performance at the upcoming HTPD meeting in Madison, Wisconsin in June.

R. Nazikian visited UC Davis to discuss microwave technology development and presented a seminar on the challenge of ELM transients in fusion plasmas. He also visited LLNL to present a talk on recent developments in the use of resonant magnetic perturbations to suppress ELMs in fusion plasmas.

ADVANCED PROJECTS (H. NEILSON):

The Laboratory welcomes Dr. Iván Vargas Blanco, who this week began a three-month visit to work with PPPL staff on application of stellarator and full-wave codes to experiments at the Costa Rica Institute of Technology in Cartago, Costa Rica. Dr. Vargas heads the Institute's Plasma Laboratory for Fusion Energy and Applications, which hosts two experiments: the SCR-1 stellarator and the MEDUSA-CR spherical tokamak. The visit will strengthen U.S. ties as well as the U.S. and Costa Rican fusion programs, which already enjoy significant international support.

The Laboratory's TDU Scraper fabrication project made progress this week with the release for shipment of components manufactured by Hollis Line Machine Company of Hollis, New Hampshire. Two TDU scrapers, currently in fabrication, will be installed in the Wendelstein 7-X (W7-X) stellarator during its next operating campaign to support experiments addressing research needs identified in the 2015 Plasma-Material Interaction Workshop. Each scraper includes a backplate and other metallic components which support an array of plasma-facing graphite tiles. These metallic components were manufactured by Hollis using materials qualified for use in W7-X that were supplied to the project by Germany's Max Planck Institute for Plasma Physics. Receipt of these components by PPPL will complete one of the project's milestones.

D. Gates spoke at the monthly meeting of the Princeton Chamber of Commerce on May 5 at the Marriott Hotel and Conference Center. His talk, entitled "Fusion Energy: the Economic Impacts of Federally Funded Research and Development" was well received by the Princeton Chamber. There was a lively question and answer session following the presentation.

ENVIRONMENT, SAFETY, & HEALTH (J. LEVINE):

Safety:

PPPL was awarded the Recognition Award for a low number of away from work lost time injury or illness cases in calendar year 2015 (the lab had one such case in FY2015).

The PPPL Plasma Science and Technology (PS&T) Department was awarded the Commissioner's Continued Excellence Award for working 10 consecutive years (January 1, 2006-December 31, 2015, a total of 409,100 consecutive hours) without any away from work lost time injury or illness cases.

INFORMATION TECHNOLOGY (S. ZELICK):

G. Zimmer represented PPPL at the Globus World Conference in Chicago, April 20-22. She gave a presentation entitled "Using Globus Transfer for Camera Data on NSTX-U" to conference attendees.

COMMUNICATIONS & MEDIA RELATIONS (L. BERNARD):

Media:

A podcast by "Actuality" on PPPL and fusion energy was released May 4. The podcast was produced by Sabri Ben-Achour, of WNYC's Marketplace, and Tim Fernholz, of Quartz, and features interviews with S. Prager, F. Poli, and A. Von Halle. The podcast can be viewed at http://www.marketplace.org/2016/05/05/sustainability/actuality-marketplace-and-quartz/machine-save-world.

DIRECTOR'S OFFICE (C. AUSTIN):

On May 4, Chuck Pell of Physcient, presented a colloquium entitled, "Modern Surgical Technology."

This report is also available on the following web site:
http://www.pppl.gov/publication-type/weekly-highlights